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Endovascular Management of Complex Splenic Aneurysm with the "Amplatzer" Embolic Platform: Application of Cone-beam Computed Tomography

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Introduction

Splenic artery aneurysms have the highest prevalence of all visceral arterial aneurysms (0.04%–10%). Treatment indications comprise symptomatic aneurysms, aneurysms $\geq$2.5 cm, and the presence of portal hypertension [1]. Within the last few decades, different endovascular treatment options were established by using coils, vascular plugs, or stent grafts for aneurysms occlusion or exclusion from blood flow [2–5].

The success of any endovascular aneurysm treatment relies on the secure exclusion of the aneurysmal sac from arterial perfusion. Feeding afferent and draining efferent arteries (so termed front-door and back-door access) are mostly visualized through either pre-interventional computed tomography angiography (CTA) or single-plane digital subtraction angiography (DSA). Modern angiography suites offer cone-beam computed tomography (CT) functionality, which provides a 3-dimensional reconstruction of the relevant anatomy through a single injection rotational acquisition, essentially creating a volumetric data set that can be reviewed on the fly [6,7]. This technique has been shown to allow intraoperative assessment of, eg, stent-graft positioning or transcatheter arterial embolization [8,9]. We hereby demonstrated the usability of cone-beam CT for vascular assessment in splenic artery aneurysm embolization and demonstrated its potential benefits when compared with standard DSA.

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Materials and Methods

A 65-year-old male patient, with a history of smoking 70 packs of cigarettes a year, was diagnosed with bronchiogenic carcinoma of the right upper lobe. Routine staging CT revealed an incidental finding of an asymptomatic 3.6-cm perihilar splenic artery aneurysm (Figure 1A). After intraoperative staging and curative resection (postoperative day 8), embolization of the splenic artery aneurysm was performed. The procedure was performed in a standard single-plane digital angiography suite (Axiom Artis dTA; Siemens Medical Systems, Erlangen, Germany). The right groin was prepped and draped in the usual sterile fashion. Vascular access was gained through the right common femoral artery with the ultrasound-guided Seldinger technique. A 6F renal double-curve sheath (RDC-cross-cut valve [CCV]; Terumo Destination, Terumo Medical Corp., Elkton, MD) was used to selectively engage the splenic artery. Through the renal double-curve sheath, a combination of 0.035-inch hydrophilic guidewire (Standard Glidewire; Terumo Medical Corp., Leuven, Belgium) and a 5F vertebral catheter (Terumo Medical Corp., Somerset, NJ) were advanced into the splenic artery. With the catheter placed in the mid portion of the splenic artery, intra-arterial contrast injection was performed with both standard DSA and cone-beam CTA.

2-Dimensional DSA

Single-plane DSA images were acquired by using standard single breath-hold acquisition and intra-arterial injection of iohexol contrast media (Optiray 320; Tyco, Montreal, Canada) at an injection rate of 3 mL/s for a total of 15 mL.

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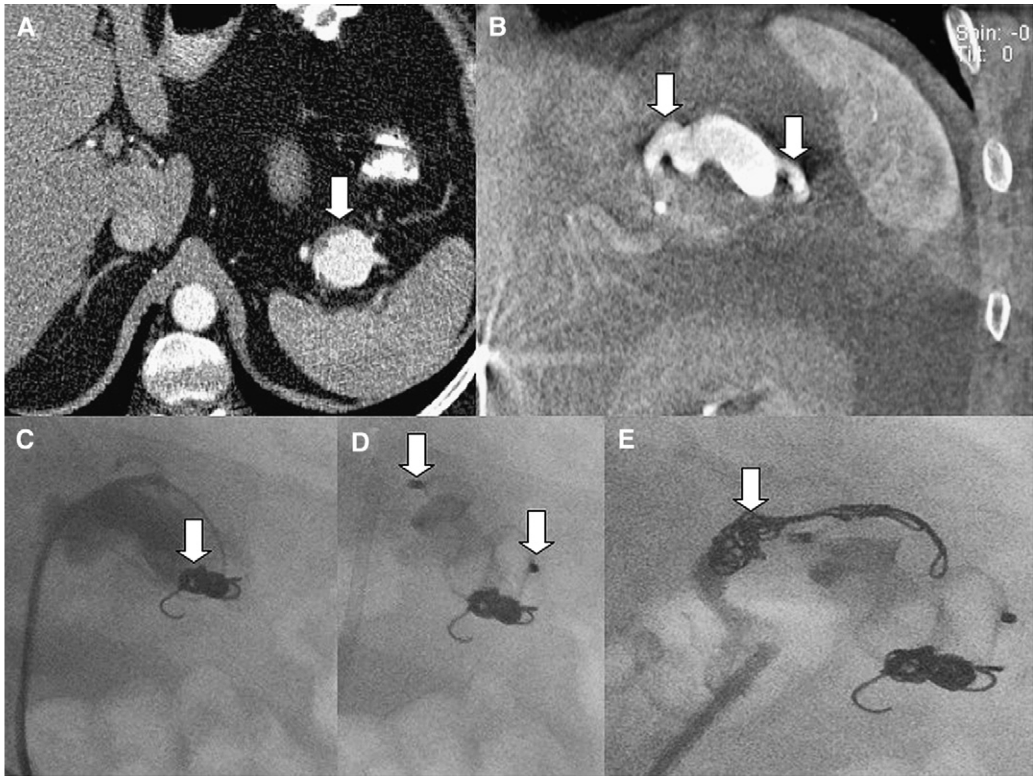

Figure 1. (A–E) Computed tomographic angiography (axial view) revealed the 3.6-cm prehilar splenic artery aneurysm (arrow in [A]). Cone-beam computed tomography (coronal view) documented extent of the aneurysmal sac, and the afferent and efferent arterial segment of the splenic artery (arrows in [B]). Embolization was performed in a 3-step approach. First the arterial ''back door'' was occluded by using two 6 mm-diameter/14 cm-length nester coils (arrow in [C]). Second, the aneurysmal sac was occluded by using a 22 mm-diameter/18 mm-length Amplatzer vascular plug II (arrows in [D]). Third, the afferent ''front door'' was occluded by using two 8 mm-diameter/14 cm-length nester coils (arrows in [E]).

Contrast-enhanced Cone-beam CT

In addition intra-arterial contrast-enhanced cone-beam CT (DynaCT digital angiography; Siemens Medical Systems) was performed. This technique allows volumetric data acquisition within a single rotation of detector and x-ray source based on unsubtracted rotational images.

Contrast-enhanced cone-beam CT images were acquired with the following parameters: a 48-cm field of view, isocenter at the splenic artery (catheter tip), and injection rate 3 mL/s for 24 mL, 2-second x-ray delay, 3 degrees per frame, single breath hold, and 200-degree arc rotation (30 degrees per second). Images were then reconstructed on a commercially available workstation (syngo X-workplace; Siemens Medical Systems) as maximum intensity projections, with on-the-fly volumetric analysis. Assessment included size and morphology of the aneurysm, visualization of the afferent-efferent arterial segment, and depiction of branching vessels.

Embolization Procedure

After angiographic assessment (Figure 1B), the embolization procedure was performed with ''back-door'' (efferent arterial segment) occlusion by using two 6 mm-diameter, 14 cm-length, 0.035-inch nester coils (Cook Inc., Bloomington, IN) (Figure 1C). The aneurysm was occluded with a 22 mm-diameter/18 mm-length Amplatzer vascular plug II (AGA Corp., Plymouth, MN) via a 7F MP A1 catheter (Cordis, Miami Lakes, FL). The afferent ''front door'' was occluded by using two 8-mm nester coils (Cook Inc.) (Figure 1D and E).

Control DSA documented total occlusion of the splenic artery aneurysm. The catheter and sheath were removed, and the arteriotomy site was controlled by using a closure device. No intraprocedural complications were observed. The patient was discharged in good condition after 2 days.

Discussion

Cone-beam angiographic CT is a new technique that is commercially available in high-end angiography suites. This technique enables acquisition of CT-like images through backprojection of rotational unsubtracted images [6]. Unlike with standard CTA, these images may be obtained either before, during, or after an endovascular intervention ''on the fly,'' without the need for a separate CT scanner or patient transport. Besides this logistic benefit, it has been established that cone-beam CT is superior to standard 2-dimensional DSA when identifying tumour-feeding arteries in transarterial chemoembolization of hepatocellular carcinoma or even fistulous points of dural arteriovenous fistulas [10,11].

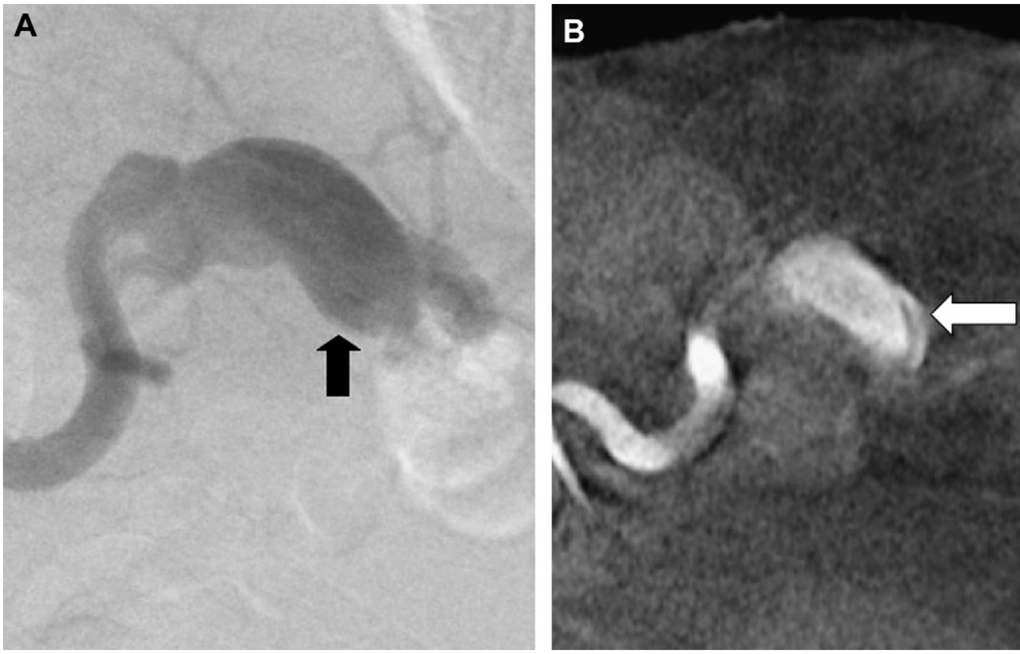

Figure 2. (A, B) Two-dimensional digital subtraction angiography revealed the extent of the aneurysmal sac 8 (arrow in [A]) and visualized the afferent and efferent arterial segment of the splenic artery aneurysm; however, a short gastric artery, originating from the aneurysmal sac was not seen on digital subtraction angiography images but revealed on cone-beam CT (arrow in [B]).

We hereby demonstrated the applicability of cone-beam CT for the pre-interventional planning of splenic artery aneurysm embolization. Compared with 2-dimensional DSA, only cone-beam CT was able to depict even a small, short gastric artery branching from the aneurysmal sac (Figure 2); a potential source of continued endopressure of the sac, and a potential therapeutic catastrophe if only efferent and afferent vessels were managed (which would preclude further endovascular intervention). The identification of the short gastric artery within the aneurysm sac changed the course of management, which resulted in deployment of a vascular plug device, in addition to embolization of the afferent and efferent arterial segments. Cone-beam CT, furthermore, should be easily transferable to facilitate complex aneurysm embolization procedures in other vascular territories.

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